DOCUMENT RESUME

ED 284 718 SE 048 261

TITLE	...And Gladly Teach: A Ford Foundation Report on the Urban Mathematics Collaboratives.
INSTITUTION	Ford Foundation, New York, N.Y.
REPORT NO	ISBN-0-916584-27-5
PUB DATE	Jun 87
NOTE	42p.; Appendix D contains small print on gray background.
AVAILABLE FROM	Ford Foundation, 320 East 43 Street, New York, NY 10017 (free).
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Cooperative Programs; *Elementary School Mathematics; Elementary Secondary Education; Mathematical Applications; Mathematical Enrichment; Mathematics Education; *Mathematics Instruction; Professional Recognition; School Business Relationship; School Community Relationship; *Secondary School Mathematics; Teacher Administrator Relationship; *Teacher Morale; *Urban Schools; Urban Teaching
IDENTIFIERS	*Ford Foundation

ABSTRACT

In February, 1985, the Ford Foundation launched an experimental program to strengthen mathematics education in inner-city high schools. Five grants helped establish urban mathematics collaboratives (UMC) in Cleveland, Minneapolis-St. Paul, Los Angeles, Philadelphia, and San Francisco. Later, additional UMCs were set up in Durham, Memphis, New Orleans, Pittsburgh, San Diego, and St. Louis. A UMC typically consists of a community advisory board that includes teachers, school administrators, and leaders from business and higher education. This booklet is a preliminary report on the first two years of the UMC initiative. The first chapter is a brief discussion of the program's links with other efforts addressing problems in the teaching profession. The rest of the booklet describes the start-up experiences of the collaboratives and suggests general principles about marshalling local resources on behalf of teachers. The appendices include a list of selected collaborative activities that have occurred at the 11 cooperatives, sample mathematics problems, sample comments on problems, and a newsletter from one of the UMCs. (TW)

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"And gladly would he learn and gladly teach."
Geoffrey Chaucer, The Canterbury Tales

. . . And Gladly Teach

Billy E. Barnes

At the North Carolina School of Science and Mathematics, the host institution for the Durham project, teachers participate in a workshop on computers and high school mathematics.

Roger Mastroianni/Barney Taxel & Co.

Mathematics teacher LaMoyne Porter, a member of the Cleveland collaborative's advisory board, is a regional coordinator of EQUALS, *a program aimed at engaging female, minority, and other "at risk" students in mathematics.*

Roger Ressmeyer

Teachers from the San Francisco collaborative discuss the math underlying the exhibits at the Exploratorium science museum.

One of a series of reports on activities supported by the Ford Foundation. A complete list of publications may be obtained from the Ford Foundation, Office of Reports, 320 East 43d Street, New York, N.Y. 10017.

Library of Congress Cataloging-in-Publication Data

And gladly teach.

1. Mathematics—Study and teaching—United States. I. Ford Foundation. II. Title: Urban mathematics collaboratives.
QA13.A535 1987 510'.7'1173
87-11864 ISBN 0-916584-27-5

456 June 1987

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Preface

In February 1985 the Ford Foundation launched an experimental program to strengthen mathematics education in inner-city high schools. Five grants, totaling $379,000, helped establish urban mathematics collaboratives (UMC) in Cleveland, Minneapolis-St. Paul, Los Angeles, Philadelphia, and San Francisco. Over the next eighteen months the establishment of math collaboratives in Durham, Memphis, New Orleans, Pittsburgh, San Diego, and St. Louis completed the planned set of eleven projects. The collaboratives will receive Foundation support for three to five years before becoming completely self-sustaining programs. To date, the Foundation has committed more than $2 million to the UMC initiative.

An urban mathematics collaborative typically consists of a community advisory board that includes teachers, school administrators, and leaders from business and higher education; a series of subcommittees that oversee specific collaborative functions; and a part-time administrative staff. The goal is to involve virtually all of a city's high school mathematics teachers in a diverse set of school-year and summer activities, jointly designed and operated by teachers and mathematicians from educational, cultural, and business institutions. Specific collaborative activities include industrial internships, exchange programs with colleges and industries, evening symposia, newsletters, and summer workshops. By fostering colleagueship among mathematicians and increasing the human and financial resources available to teachers, the projects seek to reduce teachers' isolation, to boost their professional enthusiasm, to enhance both their receptivity to new ideas and their capacity to discriminate among them, and to encourage resourcefulness in their teaching.

The UMC initiative is part of the Ford Foundation's ongoing effort to strengthen institutions working to improve the economic well-being and quality of life of the urban poor. Among these institutions

are community-based organizations, human-services agencies, and schools. For reasons of social justice and economic health, assisting inner-city schools is vital work. These schools educate large numbers of minority students, whose educational opportunities lag behind those of their more affluent suburban counterparts. Despite their disadvantage, minority students are destined to play an increasingly important role in the work force and in all of the nation's major institutions. In 1950 less than 15 percent of those eighteen and under were minorities; today the figure is 36 percent and growing.

Because our society rests on an economy increasingly dependent on science and technology, the substantive focus of the UMC initiative is mathematics. Quantitative, analytical, and problem-solving skills are essential intellectual tools in the "information age." Students inadequately prepared in these areas may find their career opportunities limited, their chances of underemployment and unemployment increased, and their talent and potential wasted.

In addition to improving mathematics education in eleven cities, the collaboratives are addressing structural problems in the teaching profession that hinder effective education and the recruitment and retention of good teachers. Among these problems are teachers' isolation, inadequate opportunities to renew their professional knowledge, and their limited role in developing curricula and school policies and practices. By encouraging mathematics teachers to act as self-directed professionals, the collaboratives are providing lessons that apply to teachers of all subjects.

To help the collaboratives attain their ambitious goals, the Foundation has established an information and resources project, coordinated by Mark Driscoll of the Education Development Center in Newton, Massachusetts. This project provides the collaboratives with information about mathematics and mathematics education, helps them plan and implement their individual programs, and facilitates communication among the various projects.

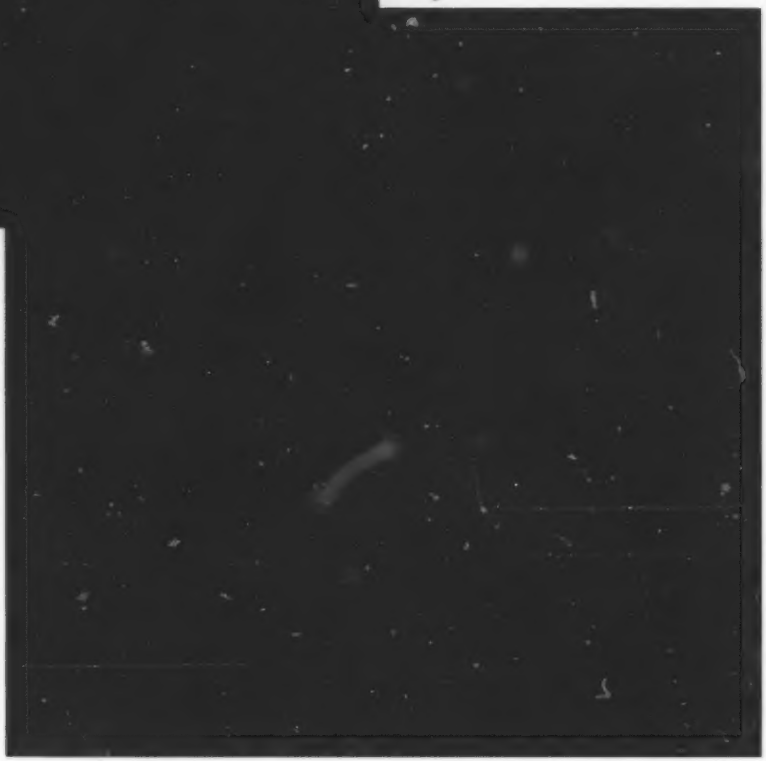
The Foundation has also established a documentation project that monitors the activities of the collaboratives and assesses the impact of the individual projects and the group as a whole. Directed by Thomas Romberg of the Wisconsin Center for Educational Research, the documentation team is examining the various strategies for building collaborative networks; the effects of the initiative on teachers' morale, knowledge of mathematics, and sense of professionalism; the ways in which the projects identify critical issues in mathematics education; and, ultimately, the impact of the collaboratives on learning.

This booklet, written by Program Officer Barbara Scott Nelson and William Rust of the Office of Reports, is a preliminary report on

the first two years of the UMC initiative. The first chapter is a brief discussion of the program's links with other efforts addressing problems in the teaching profession. The rest of the booklet describes the start-up experiences of the collaboratives and suggests general principles about marshaling local resources on behalf of teachers. By reviewing some of the strategies pursued and the lessons learned by the projects, the Foundation hopes to assist and encourage other cities interested in undertaking this important and rewarding work, and to share insights emerging from the first years of the UMC initiative with educators, community leaders, and others concerned about the profession of teaching.

Susan V. Berresford
Vice President, United States
and International Affairs Programs
Ford Foundation

Trusting Teachers



Before becoming project coordinator of the Memphis Urban Mathematics Collaborative, Nancy Gates taught high school math in the city's public schools for seventeen years. The twelfth largest system in the country, the Memphis public schools serve 105,000 stu-

dents, approximately two-thirds of whom are black. More than half of the system's students are from low-income families.

For Gates, recipient of a Presidential Award for Excellence in Mathematics Teaching and other professional honors, a typical day as a teacher began at 7:30 A.M., when she would take roll, collect absence notes, and attend to other clerical and administrative duties associated with the thirty or so students in her home room. Her usual teaching load was five classes, each averaging twenty-five students, of second-year algebra, trigonometry, and other upper-level courses. Exacerbating the problem of providing meaningful instruction to 125 students per day was her hall-monitoring responsibility during the five minutes between classes, a duty that robbed students of precious moments of individual attention. "I hate standing in the hall," says Gates. "You need that time."

Her lunch hour was thirty minutes long, and her extracurricular activities included coaching the math team and sponsoring the local chapter of Mu Alpha Theta, an honorary mathematics club. Grading papers and preparing lessons and tests occupied after-school hours and evenings.

Such a schedule provided little time for keeping abreast of new topics in mathematics and math education or for exchanging ideas with her teaching colleagues. On her own time, Gates read professional journals, attended conferences, and sought out teaching colleagues. The school system, which did not grant leave for meetings of the National Council of Teachers of Mathematics, provided few resources or incentives to keep in touch with the affairs of her profession. "It was left up to the individual," she says.

What was not left up to individual teachers was how to teach their own students. For reasons of accountability and standardization, the school system had developed prescribed curricula and textbooks. A "pacing manual" told Gates how quickly to cover the material. Designed to ensure a basic level of instruction, these standardized teaching methods give teachers few opportunities to tailor their lessons to the needs of their classes. Says Gates of this mechanized approach, "It doesn't work."

The problems faced by Nancy Gates are not confined to teachers in Memphis or in urban schools more generally. Because of the structure of the teaching profession, these problems are shared by virtually every public school teacher in the country. Unable to delegate administrative or clerical chores, teachers everywhere are burdened by heavy teaching loads and isolated from colleagues in their own departments, from administrators who establish educational policy, and

from the community at large. Prescribed curricula and teaching techniques sharply limit teachers' opportunities to exercise professional judgment, thus discouraging some of the best teachers. Others, educated many years ago, sometimes have an incomplete knowledge of contemporary mathematics and its applications. Yet resources to help them update their knowledge are often scarce. Such working conditions are exacerbated by a lack of permanent study space and limited access to telephones and photocopying machines. Individually, these conditions may seem trivial. Collectively, they form a serious barrier to effective professional work.

In recent years the problems of the teaching profession have attracted great national attention. Several major reports* have included among their recommendations: a more professional environment that allows teachers to determine how to meet goals for student achievement, opportunities for teachers to exercise educational leadership within their schools, a reduction of the isolation of educational professions from the "real world," and incentives for continuous professional growth for teachers. The Ford Foundation's UMC initiative addresses these issues in a spirit of inquiry, viewing teachers and schools as important sources of insight into what the professional life of teachers should look like and what they need to do their job well.

The serious problems in the teaching profession addressed by the collaboratives include:

Teacher responsibility and accountability. Some argue that today's teachers are like factory foremen who efficiently maintain a production line and manufacture products designed by others. A more professional view of responsibility would engage teachers more deeply in enriching their knowledge of subject matter and of pedagogy, in developing curricula and school policies and practices, and in devising ways to retain students' interest and commitment to schooling. Teacher responsibility and accountability is an issue on which several reports have focused. The Holmes Group suggested how teachers should be educated to fulfill these expanded responsibilities. The Carnegie Task Force proposed a national examination to certify the most proficient teachers, giving them leadership positions within schools. Moreover, entire schools would be held accountable for student per-

*_A Call for Change in Teacher Education_ by the National Commission for Excellence in Education of the American Association of Colleges for Teacher Education; _A Nation Prepared: Teachers for the 21st Century_ by the Carnegie Forum on Education and the Economy; and _Tomorrow's Teachers: A Report of the Holmes Group_.

formance, thereby encouraging the staff to work as a team. **The role of the collaboratives is to help teachers to explore new professional and intellectual relations in and out of school, to develop a deeper knowledge of mathematics, to show how the curriculum might be revised, and to work together with school administrators to achieve common educational goals.**

Teacher isolation. The school day is so tightly scheduled that teachers have little opportunity to talk with one another or to think about how they might do their job better. They are paid to be in classrooms and to be narrowly task oriented. In the collaboratives, it is apparent that **teachers are aching to talk with one another, to watch each other teach, and to enrich their social and professional contacts.** The larger issue is the degree to which teaching has been conceived as a narrowly instrumental activity, improvable by "in-service" days and other specific "technical fixes" aimed at updating the skills and knowledge of teachers. Good thinking, learning, and exploration can only be done under conditions of high expectation, firm support, and adequate time to struggle with ideas and talk about them with others. The activities of the collaboratives are designed to balance the needs of teachers for new information about mathematics and pedagogy, for broader intellectual stimulation, and for collegial relations with other teachers.

Institutional divisiveness. Frustrated by an educational system that seems unresponsive to their needs, many teachers are angry, apathetic, or cynical. Much of this frustration is focused against school administrators, who often feel that teachers do not fully appreciate the constraints on their decision making. The collaboratives, multi-year projects that bring teachers together with school administrators and community leaders, **create an environment for healing bruised relationships.** There is time for teachers to begin to trust their school systems and to work to improve them. These developments owe much to the vision of school principals, mathematics supervisors, and school superintendents who have recognized that actively involving teachers in their own professional development is highly beneficial to teaching and learning.

Getting Started

In July of 1984 Sondra Hardis, a program associate on the Standard Oil Company's corporate-contributions staff, received a telephone call from the Ford Foundation, asking her advice about a new project. The Foundation, she learned, was requesting proposals from

several cities to establish urban mathematics collaboratives, which would seek to enhance the professional development of math teachers in inner-city high schools. Hardis was asked if she would help convene mathematicians, educators, and community leaders in Cleveland to prepare such a proposal.

Hardis found the prospect of transforming the Ford Foundation's idea into a local reality intimidating. Exaggerating only slightly, she recalls with a smile her response to the request: "I said, 'Yes,' then got off the phone and panicked. What to do next?"

The question posed by Hardis, currently a member of the advisory board of the Cleveland Collaborative for Mathematics Education, was only one of many asked by the communities that have established collaboratives: Who should we involve in the project? What are our human and financial resources? How do we get teachers to participate? What are appropriate and feasible activities?

Because of the overall design of the UMC initiative, there were no pat answers applicable to all cities. Seeking a diverse set of urban communities, the Foundation sought proposals from cities of varying size, geographical region, and industrial base. Such diversity prompted individual answers to organizational and other questions. For example, in Los Angeles, the largest city to host a collaborative, the project leaders decided to concentrate on three pilot schools and branch out gradually, rather than spread their limited resources and activities over a school district with more than 1,600 high school mathematics teachers. On the other hand, in Durham, the smallest city to form a collaborative, there are only ninety-five math teachers in the entire county. This collaborative has decided to increase its teacher population and resource base by gradually expanding into Raleigh and Chapel Hill.

The range of institutions hosting the collaboratives also precluded common answers to the questions most frequently raised by local groups. The host institutions in the UMC initiative include a science museum, a university department of mathematics, a university mathematics education department, a public high school for academically gifted students, a local affiliate of the National Urban League, and several local education funds. The diversity of host institutions not only has enabled each collaborative to build on local strength, but also has provided insights into the ways various groups marshal financial and human resources on behalf of teachers.

Wherever collaboratives have been established, they have started by **building on local educational, business, or scientific resources that provide the initial impetus for the project.** For example, the Exploratorium, a hands-on science museum with more than 600

exhibits, has played a key role in the evolution of the San Francisco collaborative. In 1985 and 1986, the museum hosted a four-week summer institute for teachers that focused on the mathematics underlying the exhibits. During the academic year, the Exploratorium has held follow-up sessions that provide teachers with additional intellectual stimulation and networking opportunities.

The School of Mathematics at the University of Minnesota, the host institution for the Twin Cities Mathematics Collaborative, has also sponsored summer institutes. There, the substantive focus has been mathematical problem solving, which views mathematics not as a sequential series of computational techniques, but as an exploratory and analytical process for dealing with new situations. Says Christopher Ennis, former project coordinator of the collaborative, "The interaction that goes on between the teachers and the faculty here has done as much as the content in making them loosen up and feel good about being members of the mathematical community."

Sources of strength for mathematics collaboratives are, of course, not confined to institutions capable of hosting summer workshops. In Cleveland, Standard Oil Senior Vice President William P. Madar provided much of the initial impetus for the collaborative, serving as chairman of the advisory board and bringing in significant funding. Knowledgeable about the city's political, social, and educational climate, Madar had sufficient stature in the community to attract other top executives to the collaborative. At the very first meeting of the advisory board, he announced: "People sitting on this committee should be people who can't afford to be here." In other words, the collaborative needed the support of business executives who had the authority to make decisions on behalf of their companies.

Local education funds are sources of strength for the collaboratives in Cleveland, Los Angeles, New Orleans, Pittsburgh, and San Francisco. Affiliated with the Public Education Fund of Pittsburgh, local education funds are nonprofit, community-based funding agencies engaged in efforts to improve public schools. The "ed funds" make modest grants for improving local schools and develop supportive community and private-sector relationships with the public school system. Experienced in fund raising and knowledgeable about the school system, education funds are well positioned in the community to establish coalitions on behalf of teachers. "Our greatest strength and unique ability," says Gladys Thacher of the San Francisco Education Fund, "is to build a constituency for the public schools."

A primary task, then, for a community seeking to establish a collaborative is identifying local sources of support and encouragement. Such resources need not be limited to the kinds of organizations that

anchor the existing collaboratives. It may be possible, for example, for a local chamber of commerce or an educational committee of a professional organization to host a collaborative.

Each kind of host institution has natural strengths and weaknesses for supporting the collaboratives' professional and networking activities. Universities, for example, can provide teachers with high-quality mathematical programs, but they may have difficulty in getting financial support from the corporate sector. Education funds, on the other hand, have many contacts in the business community, but they do not necessarily know much about mathematics. **The key, therefore, is the early establishment of a broad coalition of community resources,** with many organizations sharing a proprietary interest in the collaborative. Such a coalition not only provides complementary strengths to the collaborative, but also gives each participating institution an ownership interest in the success of the project.

It may be difficult to harmoniously bring together representatives of the diverse groups that constitute a collaborative—the public school district, science museums, universities, community colleges, local businesses and industries, and, of course, teachers. In general, these people will not have worked together before, and they may have stereotypical ideas about one another and very different ideas about what constitutes good mathematics education.

Ironically, teachers, who are the most direct beneficiaries of the collaborative, may be one of the hardest groups to bring into the project. Some teachers are angry, feeling betrayed by school systems whose agendas often appear more political or bureaucratic than educational. Some teachers, skeptical of programs on their behalf, have been disillusioned by unsuccessful efforts in the past. "Teachers are used to seeing something go for one year and then dropped," said one Cleveland school teacher. "I've been in four or five of those projects myself, and it is a disaster [when they are canceled]."

Communication among the various groups constituting the collaborative may be hindered by unfamiliarity with each other's worlds. In several projects, teachers initially had difficulty in articulating their needs to business people. According to Allan Pitman of the documentation project, an early meeting between teachers from the Los Angeles collaborative and their business colleagues produced a frustrating circular conversation that went on in the following fashion:

Business: How can we help you?

Teachers: We don't know. Tell us what you can do, and we'll see if it would help.

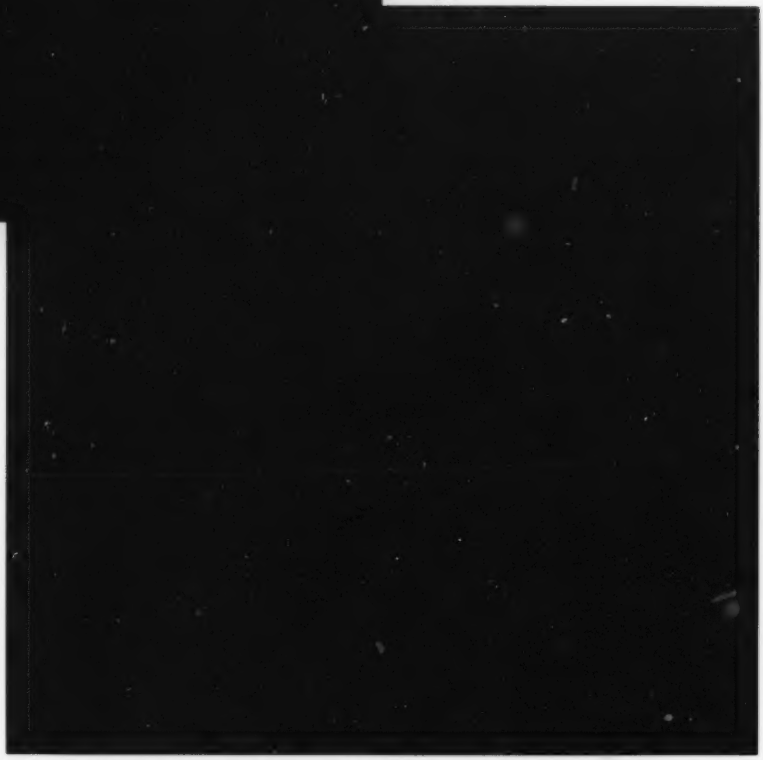
Business: Well, we do a lot of things. If you tell us what you want, we'll be able to tell you if we can do it for you.

Teachers: We don't know what we want that you might be able to give us.

The project director and the coordinator of the Cleveland collaborative had similar problems communicating with applied mathematicians in industry, who inhabit a world far removed from the realities of the classroom. Efforts to generate examples of industrial uses of mathematics repeatedly resulted in materials far too technical and advanced for high school classes.

As they spend more time with other mathematicians and participate in such activities as collaborative-sponsored dinner lectures and industry tours, teachers have become increasingly effective in communicating their professional needs to the larger mathematics community. For example, in collaboration with the Los Angeles project, the Hughes Aircraft Company has produced a book of problems based on the use of mathematics in the aerospace industry (see Appendix B, page 34). Appropriate for high school students, the problems progress from elementary to higher mathematics and demonstrate to students how mathematics can solve "real world" problems. This document has also been useful to other collaboratives, which now have a model to show businesses and industries in their communities. As acquaintances deepen and products emerge, teachers develop confidence that the collaborative is here to stay and that it is, in fact, a vehicle for improving math education in their city.

Activities



To provide teachers with the skills, resources, and opportunities that encourage professional growth, the math collaboratives have sponsored a rich blend of in-school, out-of-school, and networking activities. They include dinner lectures, tours of industry, internships,

summer courses and follow-up workshops during the school year, mini-grant programs, teacher resource centers, newsletters, fellowships, and opportunities to travel to regional and national professional conferences.

Virtually all of the collaboratives have sponsored some form of dinner lectures featuring speakers from business, industry, and higher education. For example, with help from the California Roundtable's Mathematics/Science Task Force and Chevron U.S.A., the San Francisco Mathematics Collaborative has established a Nobel Dinner Lecture Series. Topics in the series have included the anti-proton and anti-matter, environmental influences on brain structure, and economic forecasting. In Pittsburgh, the Westinghouse Electric Corporation sponsored the collaborative's kick-off event, a dinner and lecture on discrete mathematics and other new topics in math education. Such gatherings provide teachers with intellectual stimulation, recognition for their educational contributions, and opportunities to socialize with school colleagues, other mathematicians, and community leaders.

Two other common activities are industry tours and internships, both of which provide teachers with hands-on experience in the business and research applications of mathematics. In Durham, for example, fifteen city and county teachers visited the National Institute of Environmental Health Sciences and learned about the use of mathematics in determining the cancer risk associated with exposure to chemicals. The seminar was videotaped for later use by other teachers. In Cleveland, the collaborative developed ten summer internships in industry for math teachers who also participated in a graduate-level seminar on the relationship between work in industry and mathematics in school.

As the initial activities of a collaborative, dinner lectures, internships, and visits to business and industry need not—and perhaps should not—be directly aimed at developing lesson plans or addressing specific topics in mathematics education. Instead, **these activities appear to be a necessary first phase that helps to legitimize teachers as professionals in the community, to broaden their definition of professional needs, and to stimulate their intellectual curiosity.** "If you were to have asked a teacher two years ago, 'What do you need and what would you like?' most of them would have responded, 'More chalk, more paper, better textbooks,'" says Theresa Hernandez-Heinz, a math department head and former project coordinator of the San Francisco collaborative. "Now they would be talking about speakers they would like to hear, field trips they would like to participate in, and experiences they would like to have."

One of the challenges facing the existing projects is capitalizing on these new perspectives through the creation of activities that promote even deeper professional growth and collaboration. In Cleveland, Minneapolis-St. Paul, and Los Angeles, teachers and other math professionals are working together as peers on education projects, pooling their knowledge about the capabilities of high school students and the business and industrial applications of mathematics. The goal of these activities is to develop curriculum units that are both pedagogically and mathematically correct. Trigonometry, for example, is embedded in robotics. By matching teachers of trigonometry with industry people involved with robotics, it will be possible to develop highly focused curriculum units based on an industrial application of mathematics. Another set of activities growing out of the collaboratives' first year has helped teachers develop their critical skills. In Pittsburgh and Cleveland, for example, teachers are pilot testing prospective textbooks and designing a study of their effectiveness.

Summer institutes, seminars, and follow-up workshops provide teachers with **sustained intellectual stimulation and opportunities to meet with and learn from other teachers.** Many teachers at the summer institutes at the Exploratorium and the University of Minnesota called the latter benefit the most important part of the course. In the classroom, explains Theresa Hernandez-Heinz, "you hear yourself and only yourself speak. And it is a very lonely echo. Now there is a network, and I have people who will work with me and help me."

The summer institutes at the Exploratorium and the University of Minnesota share another important feature: **the instructors regard high school teachers as professional peers and colleagues who help shape the direction of the course.** Moreover, both institutes have helped teachers assume leadership roles within their collaboratives. According to Harvey Keynes, project director of the Twin Cities Urban Mathematics Collaborative, the summer institute was the project's "single most effective" activity.

Several of the collaboratives have mini-grant programs offering teachers up to $500 for innovative projects to enrich classroom experiences. For example, a Philadelphia teacher, seeking to capitalize on his students' fascination with computers, received a small grant to purchase software programs in problem solving, computer literacy, and other mathematical topics. Despite sporadic successes, mini-grant programs have attracted relatively few quality proposals, a situation some project directors attribute to teachers' heretofore limited professional experiences. The collaboratives anticipate a growing number of creative proposals as teachers' professional horizons are broadened by other project activities.

Some of the activities initially proposed by the collaboratives have not been feasible. The Cleveland collaborative, for example, considered a series of brown-bag lunches that would bring teachers together to listen to guest speakers. The project leaders, however, discovered that teachers do not all eat lunch at the same time. Moreover, there would be problems in transporting teachers from school to school. Similar logistical difficulties helped derail a planned series of "math matinees" at the Minneapolis Museum of Science. These experiences should not necessarily be regarded as failures. **Testing activities for their suitability in a local context is an integral part of a collaborative's development.** Moreover, infeasible activities can raise telling questions about the working conditions of teachers and challenge schools to devise new arrangements that acknowledge and accommodate the needs of teachers. "Why shouldn't teachers be able to have lunch meetings?" asks a project observer.

Among the more promising in-school activities are teacher resource centers, which are being established in Cleveland, Durham, New Orleans, San Francisco, and St. Louis. The Cleveland resource center is located at the metro campus of Cuyahoga Community College. Open from 3:00 to 6:00 P.M., four days a week, the center has a large collection of professional journals, textbooks, computer software, and other teaching materials. A comfortable place where math teachers can informally share ideas, the center also sponsors guest lectures and teacher workshops. **The resource center is staffed by a rotating group of Cleveland math teachers who have gained valuable professional experience by planning and organizing the center's activities.** "When I first started out I really didn't have the guts to do any of this stuff," says Les Moes, one of the teachers who runs the center. "In the Cleveland schools, it's cast in stone: 'Thou shalt not contact anyone without seeing your supervisor, without seeing his supervisor, without seeing your principal.'"

Adds Paula Anderson, project director of the Cleveland collaborative: "Part of what we're saying is empowerment. 'You do have the power to make decisions. You do have the power to pick up the phone and make things happen. You can see that together we change something for the better.'"

The collaborative activities discussed above do not constitute an exhaustive list. By building on local strengths, new projects should adopt or adapt those activities most appropriate to their communities. Theresa Hernandez-Heinz suggests that members of collaboratives be imaginative in devising activities for teachers and ask themselves: "How can I create an environment for these professionals in which they can grow and flourish and perpetuate what is important?"

Part of the collaboratives' efforts to enhance the professional development of teachers involves **focusing on new ideas in mathematics education,** most of which revolve around reformation of the high school curriculum. Increasingly out of step with current trends in mathematics, the traditional curriculum in inner-city schools does not reflect new emphases on topics such as finite mathematics, statistics, and the applications of microcomputers. Many teachers, moreover, lack training and expertise in these areas. According to the UMC documentation project, teachers "have not shaken the belief that mathematics is a collection of concepts and skills mastered in some particular order."

A topic that virtually all of the collaboratives are examining is problem solving, which the National Council of Teachers of Mathematics has recommended as the principal focus for high school mathematics in the 1980s. This approach to math enables students to apply standard computational techniques learned by rote to unusual and unexpected situations. "Looking at mathematics as more than just a collection of tricks but as a process for solving more difficult problems is the centerpiece of this program," says Christopher Ennis of the Minneapolis-St. Paul collaborative. "If you have only one shot, don't just teach them a couple of new tricks. Teach them how to use some of the stuff they already know quite well and go beyond it."

An area of growing interest to the collaboratives is discrete mathematics, which covers such topics as linear programming, number theory, graph and network theory, probability, and statistics. The emphasis on these subjects reflects a broadening of the subject matter taught in college-level mathematics courses. Integrating computers into the curriculum is another current topic in math education that several collaboratives are exploring. Many math educators are seeking to develop ways of using computers as instructional tools rather than as substitutes for traditional drill and practice. Teachers not only should understand the applications of new technologies, but also they should have sufficient skills to help develop curriculum-reform strategies that use new technologies.

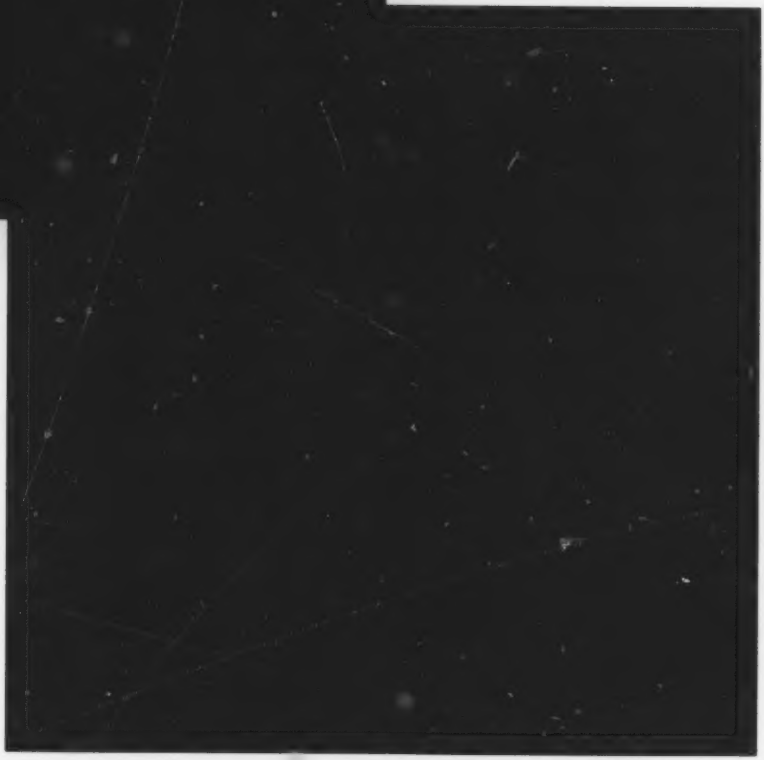
Through the collaboratives, teachers are also examining new concepts in cognitive research, which has provided fresh insights into the way students learn. According to recent research, people construct their own knowledge, organizing it in ways meaningful to them rather than simply absorbing prepackaged knowledge from outside sources. "We dole out information, the student receives it, memorizes it, and spits it back," says Theresa Hernandez-Heinz. "Mathematics is best learned in an interactive classroom where there is real dialogue."

Finally, the collaboratives are explicitly addressing the task of

increasing minority and female participation in upper-level math courses. Students attending schools in low-income communities do not have the same learning opportunities as their counterparts in more affluent neighborhoods. Inner-city girls and minorities, in particular, are mathematically "at risk." The mathematics collaboratives have aggressively sought out materials and programs developed especially for these students—for example, the EQUALS math materials developed by the Lawrence Hall of Science at Berkeley. Moreover, teachers involved in the mathematics collaboratives are learning from their university and business colleagues about good jobs likely to be available in their cities and the kinds of mental skills students will need to get and hold these jobs.

In all curriculum areas, the collaboratives not only are seeking out the best mathematics materials and teaching practices, but also they are helping develop new math programs and activities. For example, teachers in several collaboratives will pilot test mathematics- and science-curricula projects funded by the National Science Foundation. Such activities indicate that **the collaboratives are beginning to serve as mathematics magnets for their schools.**

Governance, Administration, and Fund Raising



Although details vary from project to project, **the governance structure of a collaborative is usually divided into three interlocking parts: an advisory board, a project directorate, and a teacher board.** Ranging in size from seven to thirty-five members, the advisory board

is a committee of representatives from local business, cultural, and educational institutions who—together with teachers—provide overall direction and assistance to the collaborative. Subcommittees of the board may be responsible for such administrative activities as fund raising or for overseeing specific program activities. These subcommittees work best when they reflect the heterogeneity of the membership of the overall project.

The project directorate, generally consisting of a half-time director, a half-time coordinator, and support staff, implement the advisory board's decisions. In most collaboratives, the director is responsible for the overall policy direction of the project; the coordinator handles day-to-day activities. Regardless of its specific governing and administrative structure, a collaborative must clearly articulate job specifications and responsibilities. In one project, the lack of clear responsibility for fund raising was a counterproductive point of tension between the director and coordinator.

To ensure that teachers are active participants in the collaboratives rather than passive clients, most of the projects have established teacher advisory boards. The goal of all the projects is not just to enhance teachers' ability to define their own professional needs, but also to have teachers play leadership roles in their collaboratives. As a result, teachers are beginning to use the leadership skills developed in the projects to participate in school decision making and in local and regional professional associations.

For a variety of reasons, enlisting the active involvement of teachers in the governance and administration of a collaborative is not always easy. Part of the problem is the current structure of the profession. Teachers do not control their time in the same way that attorneys, physicians, and other professionals do. Wary of educational disruption caused by their absence from the classroom, pessimistic about the availability of paid release time, or protective of their out-of-school time, teachers may need to learn that a successful collaborative requires a professional commitment of their time and energy. "Everybody is putting something in the pot," says Paula Anderson of the Cleveland collaborative. "No one is just receiving."

Teachers in the urban mathematics collaboratives have found that thoughtful and responsible expectations for themselves and their students can be met. Yet becoming active in their own professional development poses important challenges for teachers and the collaboratives supporting them. As they attempt to enhance their professionalism and update traditional ways of mathematics instruction, teachers will need to find in their school systems sources of responsiveness and support rather than resistance. Key participants

will be mathematics supervisors and other school administrators who see teachers actively participating in their own professional development as assets in the provision of high-quality mathematics education. **New collaboratives must think creatively about involving school administrators in the projects and enlisting their support in improving mathematics education.** For the collaboratives to succeed, teachers and administrators must learn to listen to one another's point of view and begin to see one another as resources in the joint task of providing an adequate mathematics education.

The annual costs of the collaboratives, including dollar estimates of in-kind contributions, range from $120,000 (Durham and Minneapolis-St. Paul) to $300,000 (Los Angeles). Several medium-sized collaboratives (Cleveland, Philadelphia, Pittsburgh, and San Francisco) cost about $200,000 per year. Most of these costs are covered by the in-kind services contributed by local businesses, industry, and educational institutions—a heartening indication of communities' willingness to support their teachers. **The actual cash requirements of a new collaborative range from $40,000 to $60,000 per year,** a level of support currently provided by the Ford Foundation. Once a collaborative reaches a steady state, estimates of their annual cash requirements drop to the $30,000 to $40,000 range, or less.

In raising funds, new collaboratives may face a hen-or-egg problem: How do you attract initial cash commitments without having an established track record? As implied earlier, the early involvement of one or more prestigious local institutions may be of help in this task. In Minneapolis-St. Paul, the collaborative found that while local industries generously provided in-kind services, they were reluctant to contribute cash before the school district provided money. "To a certain extent," says Chris Ennis, "people in industry asked, 'What are the schools doing? Do they just want a free ride? If this is going to be a collaborative, they've got to contribute too.'" After extensive discussions between the collaborative, school board members, and district administrators, the Minneapolis and St. Paul school districts each agreed to make unrestricted cash contributions for 1986–87. This support, says Ennis, greatly facilitated fund raising in industry.

The Cleveland collaborative has been particularly creative in its approach to fund raising, tapping companies' operating budgets—rather than the more traditional corporate-contributions budgets—to fund dinner symposia and internships in industry. Such an approach has helped avoid competition with the city's other nonprofits for the limited funds in the corporate-contributions budgets of local companies. "We have the people on the [collaborative] board who can make those decisions for departments as to what will come out of operating

budgets and what won't," says Sondra Hardis. "If they can't make that decision, they are in a strong enough position that they can make a recommendation that will be followed."

It is not yet known how the full range of a collaborative's activities will be funded on a local basis over the long term. Although most of the collaboratives have been very successful in raising in-kind support of activities for teachers, it remains to be seen how the administrative functions of the projects will be supported after Ford Foundation funding ends in a few years. Says Harvey Keynes, "I think ultimately...you're going to need some sort of external seeding funds to keep the collaboratives going. It may be a foundation; it may be the state. And I think a lot is going to depend on how active the *teachers* are in pushing that."

As the collaboratives mature, communities are becoming increasingly aware of the benefits they provide—updated curricula, new teaching materials, higher teacher morale, increased teacher attendance at professional meetings, and a tightly knit group of people in and out of school who are working together to improve mathematics education. The Foundation anticipates that recognition of such benefits, as well as the relatively small investment required by the collaboratives, will persuade local communities to commit the resources necessary to continue the work of these projects.

Appendix A

Selected Collaborative Activities

Cleveland (established spring 1985)

- Teacher resource center
- Workshops in advanced technologies
- Summer institutes at local colleges
- Problem-solving workshops and follow-up sessions
- Newsletter
- Summer internships in industry
- Support for teachers to attend regional and national conferences
- Tuition scholarships at local universities
- Mini-grant program
- Symposia series with corporate and university hosts
- Pilot testing new textbooks
- Reforming mathematics curriculum for non-college-bound students
- Development of system-wide mathematics examinations

Durham (summer 1985)

- Five-year plan for professional development of teachers
- Conferences, seminars, and workshops on math in business
- Tours of industry
- System-wide meetings of math teachers who teach the same subject
- Support for teachers to attend national professional meetings
- Assistance in pilot testing new curricula in Durham schools
- Collaborative-wide receptions
- Newsletter
- Summer internships in industry
- Grants for university study
- Mathematics resource center for teachers
- Mini-grant program
- Development of Research Triangle Mathematics Association

Los Angeles (spring 1985)

- Team-building activities among school mathematics departments
- Grants for implementing new mathematics programs
- Workshops to develop resource books on applications of mathematics in business and industry
- Summer internships in industry
- Support for teachers to attend regional and professional meetings
- Industry tours
- Dinner meetings
- Support for teacher attendance at residential summer institutes and follow-up workshops
- Meetings with industry personnel to develop meaningful interaction between teachers and industry

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Memphis (fall 1986)

- Mentorship program
- Speakers' bureau for classroom speakers
- Summer internships in business and industry
- Summer workshops on contemporary topics in mathematics and math education
- Professional mathematics association for teachers and mathematicians in higher education and business
- Public-information program

Minneapolis-St. Paul (spring 1985)

- Twin Cities Precollegiate Mathematics Society, which sponsors dinners, lectures, and other year-round activities
- Summer problem-solving institute and monthly follow-up sessions
- Mini-grant program
- Newsletter
- Tours of industry and follow-up activities
- Teacher participation in state-wide and regional mathematics-education activities

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New Orleans (fall 1986)

- Newsletter
- Workshops for math teachers at the Louisiana Science Center
- Business/university/teacher symposium series
- Site visits and internships in business and industry
- Mini-grant program
- University courses
- Promoting community awareness of contemporary math education

Philadelphia (spring 1985)

- School-based needs assessments and development of plans for improvement
- Mini-grant program
- Enhancing access to math-related activities in the Philadelphia area
- Speakers from business, industry, and higher education
- Joint math/science department meetings in participating schools
- Support for teachers to attend local, regional, and national professional meetings
- Newsletter

Pittsburgh (summer 1985)

- System-wide meetings of mathematics department chairs
- Pilot testing new textbooks
- Support for teacher attendance at summer institutes and follow-up workshops
- Development of district plans for using calculators in the classroom
- Teacher training in computer literacy
- Industry tours
- Distinguished speaker series
- Development of state-mandated third year of high school mathematics
- Support for teachers to attend professional meetings

San Diego (spring 1986)

- Math department teams
- Monthly meetings of mathematics departments
- University summer workshops
- School-year workshops in learning theory and new topics in mathematics
- Mini-course series in discrete mathematics
- Dinner/colloquium series
- Support for teachers to attend professional conferences
- Summer internships in industry

San Francisco (spring 1985)

- Summer institute at the Exploratorium and follow-up workshops
- Dinner/lectures sponsored by local corporations
- Nobel Laureate dinner/symposia
- University and business tours
- Mini-grant program
- Support for teacher attendance at residential summer institutes and follow-up sessions

- Enhancing teacher access to mathematics-related activities in the Bay area

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St. Louis (spring 1986)

- Support for teachers to attend conferences
- Identification of material and human resources available to teachers
- Site visits to business and industry
- Workshops on proposal-writing and funding for school improvement
- Newsletter
- System-wide meetings for mathematics teachers
- Identification and implementation of innovative curricula and teaching materials

Appendix B

Sample Problems from "Applications of Mathematics in the Aerospace Industry" By Linda Barkley, Hughes Aircraft Company

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Elementary Algebra

The fuel tanks in a satellite are capable of holding 360 pounds of fuel. Every time an engine is fired it uses two pounds of fuel. If the engine is fired twice a month, how many years will the fuel last?

Geometry and Related Concepts

A spacecraft is to be soft landed on the moon with a maximum impact force of 1,500 lbs. Three legs, each with a circular foot, will support the spacecraft after landing. As a safety factor, it is assumed that the moon's surface will support a maximum of 1.5 pounds per square inch. Allowing for a possible 50% overload on any foot, determine the minimum radius of the foot.

Probability

A preliminary design for a spacecraft subsystem is composed of three units: A, B, C. The reliability, or probability of success, of each unit after three periods of operations is listed in the following table:

	1 Year	*3½ Years*	*8½ years*
A	0.9997	0.8985	0.6910
B	1.0000	.9386	.7265
C	.9961	.9960	.9959

If P_s is the total probability of success of the subsystem, find P_s for each time point.

Appendix C

Sample Comments on Problems Considered at the 1985 Summer Institute of the Twin Cities Mathematics Collaborative
By Prof. Bert Fristedt

Algebra & Trigonometry

Suppose one hose could fill a certain tank in 4 hours and a second hose could fill it in 6 hours. If the tank were full and the drain were open the tank would take 8 hours to empty. How long would it take to fill the tank using both hoses simultaneously if the drain were left open?

Comment: One need not know the size of the tank in order to do this problem, but some people felt that as a first step students should do the problem for a tank capable of holding, say, sixteen gallons of water. Someone else mentioned the idea of measuring water in numbers of tankfuls so that the capacity of the tank is necessarily one.

Here you see the tomb containing the remains of Diophantus. One-sixth of his life God granted him youth. After a twelfth more his cheeks were bearded. After an additional seventh he kindled the light of marriage, and in the fifth year he fathered a son. Alas, the unfortunate son's life span was only half that of his father's, who consoled his grief in the remaining four years of his life. By the device of numbers tell the extent of his life.

Comment: Since the problem is presumably a problem about integers, the extent of his life must be divisible (in integers) by each of 6, 12, and 7; that is, it must be an integral multiple of 84. It is not necessary to make this observation to do the problem.

By using relations among $\cos(2\pi/5)$, $\cos(4\pi/5)$, *and* $\cos(8\pi/5)$ *obtain an algebraic formula for* $\cos(2\pi/5)$.

Comment: Several people made contributions on this problem. Kingsley showed how to construct a regular pentagon with center at the origin and one vertex at the point (1,0). Then he observed that the x-coordinates of the vertices are $\cos(2n\pi/5)$, $n = 0, 1, 2, 3, 4$. This itself did not give a formula for $\cos(2\pi/5)$; but by observing exactly what cal-

culations corresponded to each step in the construction Kingsley obtained the desired formula [without obtaining relations among $\cos(2\pi/5)$, $\cos(4\pi/5)$, and $\cos(8\pi/5)$]. We never pushed Kingsley to write a careful proof that the construction he gave actually works to give a regular pentagon. Kingsley also gave a start on obtaining the formula by the method indicated in the problem. But it was Bob who was able to complete the solution along the following line.

$$\cos(2\pi/5) = \cos(8\pi/5) = 2\cos^2(4\pi/5) - 1$$
$$= 2[2\cos^2(2\pi/5) - 1]^2 - 1$$
$$= 8\cos^4(2\pi/5) - 8\cos^2(2\pi/5) + 1.$$

Thus, we are interested in solving the following quartic equation:

$$8x^4 - 8x^2 - x + 1 = 0.$$

I forget who made the observation that we must be concerned about which of the four solutions is, in fact, $\cos(2\pi/5)$; that is an important type of observation. In this particular problem it was handled by actually solving the quartic and seeing that none of a certain three of the roots could not possibly be $\cos(2\pi/5)$. By observation one solution is 1, and thus $x - 1$ is a factor. Long (or synthetic) division gives

$$8x^4 - 8x^2 - x + 1 = (x - 1)(8x^3 + 8x^2 - 1).$$

A zero of the cubic is found by trying the numerator 1 with denominators that divide 8. The number $-\frac{1}{2}$ works. Factoring out $x + \frac{1}{2}$ we obtain

$$(x - 1)(x + \tfrac{1}{2})(8x^2 + 4x - 2).$$

Now the quadratic formula gives the other two zeroes:

$$[-1 + \sqrt{5}]/4 \text{ and } [-1 - \sqrt{5}]/4.$$

Since $\cos(2\pi/5)$ is positive and less than 1, it equals $[-1 + \sqrt{5}]/4$. (Incidentally, $\cos(4\pi/5) = [-1 - \sqrt{5}]/4$.) The formula for $\cos(2\pi/5)$ can be used for an easy construction of a regular pentagon since it is easy to construct a segment whose length is $\sqrt{5}$ times the length of a given segment. One famous accomplishment of the mathematician Gauss is that he showed how to construct a regular polygon having 17 edges.

Appendix D

Sample Newsletter from the Cleveland Collaborative for Mathematics Education

THE C²ME NEWSLETTER

MAY, 1986 VOLUME 1, ISSUE 4

A PUBLICATION FOR CLEVELAND CITY SCHOOL MATHEMATICS TEACHERS

FUTURE DIRECTIONS

C²ME has now been in operation for a little over one year. As we move to the close of the first year of funding, we'd like to share with you our accomplishments that would not have been possible without your support.

During the first year of funding, C²ME operated out-of-school, in-school, and networking activities that were designed to provide teachers with opportunities for training, information, collegiality and networking with other teachers and mathematicians from business, industry, and higher education.

Many of you participated in our first year's programs. With your help, and with the involvement and dedication of the C²ME Advisory Board, we have

1. provided opportunities for three groups of mathematics teachers (a total of 28 teachers) to attend workshops in the advanced technologies at Lorain County Community College;
2. generated 11 placements for teachers for summer internships in business and industry. In a parallel effort, C²ME identified one internship at Cleveland State University. In addition, John Carroll offered 4 tuition scholarships for math courses. One teacher took courses there in summer 1985;
3. awarded 15 small grants for secondary school mathematics projects for a total of $6,170.40;
4. opened and staffed the Cleveland Mathematics Teachers Resource Center;
5. hosted, with the support of the local businesses, industries and government institutions on the Advisory Board, three dinner symposia for mathematics teachers;
6. formed a Teacher Advisory Board to the Collaborative and;
7. distributed a C²ME newsletter to teachers and Advisory Board members.

Approximately 54% of all Cleveland secondary school mathematics teachers participated in one of C²ME's programs. We at C²ME wish to thank members of the Advisory Board, teacher participants, and the teachers who helped us operate our programs for your contributions and support.

C²ME is now ready to move into Phase II (1986-1988) and is in the process of submitting a proposal to the Ford Foundation for funding. Members of the Advisory Board and the Teacher Advisory Board are presently collaborating on the goals, objectives, and programs for C²ME's next phase of activity.

While negotiations are still underway to determine C²ME's highest priorities, several directions are emerging. C²ME will continue the most successful of its programs, such as LCCC, teacher internships in business and industry, dinner symposia and small grants for secondary school mathematics projects. In addition to these activities, C²ME will begin to move in a direction that is consistent with the CPS plan for the development of mathematics teaching in the system in the years ahead and consistent with the new recommendations for reform in school mathematics.

C²ME will, in the next four years, offer programs that will enhance the effectiveness and efficiency of mathematics instruction. C²ME will assist in the formulation and implementation of math options for the non-college bound student, will begin to educate and advocate for change in mathematics education with appropriate administrative personnel, and will assist in the reformulation of what is important in the mathematics curriculum for the college-bound student.

As C²ME grows and develops, we will continue to need your support and participation in our programs. If you haven't already gotten involved in the program but would like to be involved, please do not hesitate to call us at 861-3810, or call Bill Bauer at 441-8033.

Thank you again for your participation and support. It has been an exciting year, and next year will prove to be even more exciting!

INTERNSHIPS

The Cleveland Teacher's Internship Program is in full swing again this year with some of our mathematics teachers involved as of this printing. Ed Wutsch has landed an internship, for the second year, at Eaton's headquarters. He will help the department use and develop computer graphics for intra-office communications and all levels of operations. Jonathan Lucas will teach use of computers and software packages, while developing one of his own, at the Cleveland State University computer laboratory this summer. Jonathan interned with TRW Valve Division last year. Bob Seitz, who was with Wyatt Company in 1985, will now assist TRW's Mike Robinson (the same laboratory where Maija Zuby spent the summer in 1985) in the Materials and Manufacturing Technology Center.

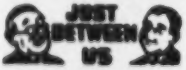
Other teachers are interviewing with TRW's Information Systems Department, Lubrizol, IBM, and Wyatt Company. Cleveland Electric Illuminating Co., National City Bank, and possibly NASA are planning to intern mathematics teachers, and so perhaps interviewing will start soon at these places.

The numbers of companies merging, down-sizing, acquiring, being acquired, divesting, are astounding. But, those actions provide opportunities, too, for teachers to provide highly valued services for the many tasks and projects that go unattended during the tumult. Their managers are struggling to clarify new roles, needs, and authority to respond, and the decisions are stretching well into the late spring. If any teacher has a question, please contact Joe Chadbourne at 464-1775.

C²ME STAFF

C²ME COORDINATOR: PAULA ANDERSON
ASSISTANT COORDINATOR: HARRIET JAKOB
ADVISORY BOARD CHAIRMAN: RICHARD LITTLE
NEWSLETTER EDITOR: BOB SEITZ

The Cleveland Collaborative for Mathematics Education would like to welcome Richard Little of Baldwin Wallace College as the new president. Dr. Little is very interested in mathematics education and we are looking forward to working with him. We would also like to thank William Mader, formerly of Solon, who did such a commendable job as the first president of our collaborative. Good luck to Bill in his future endeavors.



This is the last issue for the current school year and the newsletter staff wishes to thank all those persons who gave their time and energy to help make C²ME a reality. The mathematics teachers who have taken advantage of the many opportunities available because of our collaborative, appreciate the professional manner in which they have been treated and in knowing that someone cares about the teaching of mathematics in the Cleveland Public School System. If we are to accept teaching as a profession, then we, as teachers, must have a part in all that is happening in mathematics education, and C²ME has provided that opportunity along with a chance to develop and grow professionally. At no other time in recent memory have mathematics teachers been able to participate in such a variety of endeavors. Each of these experiences can provide us with a little more to offer the students until they will be able to display the enthusiasm and motivation necessary to study mathematics effectively. Future technological needs require more students performing well in mathematics and there is no reason why some of these students shouldn't come from our schools. We have good mathematics teachers in this system, but we all have room for improvement. Don't let this golden opportunity slip away.

The first C²ME Resource Center Happy Hour was held on Friday, April 28 at the Playdium. Several mathematics teachers attended the festive occasion along with some special friends of Les Moes. Schools represented were Whitney Young, Glenville, Public Service and Law Magnet, School of Science, John Adams, Margaret Spellacy, John F. Kennedy, Patrick Henry, and of course, Thomas Jefferson. Hopefully, this tradition will continue next year.

THE C²ME NEWSLETTER IS PUBLISHED 4 TIMES DURING THE SCHOOL YEAR, IN NOVEMBER, DECEMBER, FEBRUARY AND MAY. ANYONE WISHING TO CONTRIBUTE AN ARTICLE, PLEASE SEND IT (DOUBLE-SPACING) TO BOB SEITZ AT JOHN ADAMS HIGH SCHOOL, 3817 MARTIN LUTHER KING BLVD. 44105. I WOULD LIKE YOUR COMMENTS CONCERNING AN INTEGRATED CURRICULUM IN MATHEMATICS. SHOULD WE CHANGE OUR CURRICULUM TO ONE THAT NEW YORK HAS MANDATED? IF YOU HAVE ANY FEELING ABOUT THIS TOPIC, PLEASE SEND ME YOUR OPINION. I WILL TRY TO FEATURE AN ARTICLE ON THIS TOPIC FOR THE NEXT NEWSLETTER.

Thanks to C²ME many mathematics teachers of CPS have experienced and enjoyed professional growth and relevance of their teaching field as it is related to the real world. Through the dedication of and opportunities provided by C²ME many of us have had a unique opportunity to see what is happening in industry and it has been reinforced and demonstrated to us how important a part mathematics plays in our extremely fast paced evolving high-tech world. For me, at least, it has been inspirational to see the demand for students with good mathematics backgrounds. I feel compelled to share this information with my students. I feel my students have more faith in what I say if I can demonstrate to them that I'm forwarding this information to them from direct participation or actual observance.

Teaching in an urban school system, my participation at LCC workshop impressed upon me that many of our students should be made aware of the offering of 2-year colleges which, for many of them, would be more accessible financially and academically. I was impressed in meeting several high tech instructors who, for the most part, had started with a 2 year college. We saw concrete examples that demonstrated the importance and relevance of students interested in math and computers.

It was also morale boosting that large corporations would take time to be interested in the problems that we encounter in teaching. The high regard that many of the corporation's high ranking officials have for teachers is heartwarming. The similarity of the evolving absenteeism in the worker vs. that of the truant student seems commonly shared. Truancy in my opinion is the main culprit of having our students not achieve what they should.

I have also found it enhancing to have had the opportunity to meet and interact with other mathematics teachers. It has been a rewarding experience to renew friendships, make new ones, and to see a growing interest in math teachers participating. C²ME has given many of us a great opportunity, in interesting settings to have contemporary stimulating experiences. If you did not participate in any C²ME offerings you have missed.

Maija Zuby

LCCC SEMINAR

The following teachers attended the seminars in advanced technologies at Lorain County Community College, March 31st to April 4th:

— Millie Giamati, Thomas Jefferson Junior High School
— W. Cedric Rotolo, South High School
— Jon Lucas, South High School
— Irene Bujwalo, James Ford Rhodes High School
— Young Jo Kim, Lincoln-West High School
— Sarah Anne Vigil, Margaret Spellacy Junior High School
— Maija Zuby, Joseph M. Gallagher Junior High School
— Donald Mokren, Charles Eliot Junior High School
— Dennis Fox, M.L. King/Law and Public Service
— Francisco Soto Jr., Joseph M. Gallagher Junior High School

Changes were made on the first day of the five-day program as a result of teacher evaluations from the first two sessions at LCCC. Day 1, rather than being held at LCCC, was held in the IBM PC Executive Training Room at the Bond Court Building. The session at IBM included a presentation on the IBM PC and PC operations, hands-on experience in BASIC programming, mathematical examples using LOTUS 1-2-3, computer concepts, and a presentation on networking. Conceptually-based mathematics software was also reviewed by the teachers.

The remaining days of the five day program were held at Lorain County Community College's Advanced Technologies Center. The seminars consisted of four hours of instruction in CAD/CAM, Statistical Process Control, Computer Numerical Control and Robotics (one course each day). Teachers used the afternoons for small group work on lesson planning. The purpose of the lesson planning was to encourage thinking about ways to integrate the advanced technologies into the mathematics curriculum.

Several of the afternoons at LCCC were supplemented by further discussions or the opportunity to gain some hands-on experience with the advanced technologies. Dr. Glen Thomas Frey, Computer Technical Specialist, discussed mathematical applications of Statistical Process Control. Phil Farrider and Brenda Trimble, instructors for the Computer Numerical Control course, helped several of the teachers use a computer program, written in the COMPAC language, to instruct a machine tool to cut along a particular path in metal. Some of the teachers programmed a small instructional robot to pick up small objects, register the thickness of the object, and determine where to put the object based on its thickness.

Teachers evaluated the program daily. At the end of the week, teachers were given a certificate of participation worth 2.4 continuing education units. Teachers then completed an evaluation regarding their overall response to the program and their plans to integrate their experience into the curriculum. C²ME plans to provide more opportunities for teachers to attend seminars in the advanced technologies over the next two years of funding (1986-1988). If you haven't already taken part in this worthwhile program but would like to, watch your mailbox for details, or don't hesitate to call us at 861-3810.

Cleveland State University will develop and implement an innovative program (SMIP) to enrich and enhance the teaching capabilities of inservice, certified (9-12) mathematics teachers. The program will use self-contained modules to provide theoretical and practical instruction to strengthen the mathematical foundation in the classroom and to prepare the teacher for recommended curricular changes in the future. Through the modules, small study units, the teacher will be given background knowledge, objectives, applications, and computer and calculator activities related to specific topics. The modules will form the basis for graduate courses as well as independent study for teachers. The first course, with material related to algebra, runs from June 16 to July 3 and is tuition free. This course is already filled. However, under this program, two additional tuition-free courses have been funded for next summer. Although enrollment is open to other school districts, Cleveland Public School Teachers will be given special consideration.

With this venture in cooperative learning, Cleveland State University hopes to foster an ongoing partnership between local teachers and professors organized through a newly created mathematics education center. This center will also provide opportunities for in-depth study for academically talented secondary school students under the supervision of CSU faculty members. Support for the program is provided by a grant under Title II of the Education for Economic Security Act of 1984, administered by the Ohio Board of Regents. For more information, please contact Eli Katz at 687-4707, Roger Marty or Sherwood Silliman at 687-4684, or the mathematics department at 687-4680.

On Saturday, April 19, 1986 the Cleveland Public Schools was one of the hosts for the Greater Cleveland Council of Mathematics seventh and eighth grade mathematics contest. Thirty-three teams were entered from the Cleveland schools. This represents the largest number of teams ever entered by Cleveland schools. The following is a list of participating teachers and schools plus volunteers:

Edward Wutsch — A.B. Hart
Roger Muenger — Glenville (volunteer)
Richard Mueller — Patrick Henry
Richard Whitman — Patrick Henry
Delia Jenkins — Wilbur Wright
John Wotowiec — Wilbur Wright
Melba Gilliam — Willson
Cleveland Donerson — Willson
Mildred Giamati — Thomas Jefferson
Ken Fiore — School of Science
Margared Reed — School of Science
Congratulations on a job well done!!

Bill Bauer

Correspondence

RESOURCE CENTER

A year is nearly complete, and it is time to reflect on the accomplishments of the Cleveland Mathematics Teachers Resource Center. The Center opened in the first week in October with 45 visitors. The highlight of November was the lecture given by John Saxon, the author of several controversial mathematics texts. Mr. Saxon's lecture was quite entertaining, and thought provoking, and was attended by over 30 teachers. In January, Dr. Mark Driscoll gave an informative talk at the center on "Materials Available from the Education Development Center." Throughout the year, workshops were offered at the Resource Center, by Wallace Havenhill, and our own Ken Fiore and Les Moes.

Since the early days of last summer, Les Moes, Dick Mueller, and Ken Fiore have been in dogged pursuit of the materials needed to make the Resource Center function in a productive manner for the benefit of Cleveland mathematics teachers. To these ends, their labors have been heavily supported by donations from Cuyahoga Community College, IBM, Scott Foresman, Sohio, National City Bank, NASA, Federal Reserve System (especially the Cleveland FRB), CWRU, John Carroll, GCCTM, ECCO, Baldwin-Wallace, and Harcourt Brace Jovanovich. Space does not permit further listings, and apologies to anyone overlooked, we will rectify errors of omission in future articles.

For the future, we are working on: further diskettes of the month, more subject related samplers of our wares, more timely publicity of our activities, more services that YOU, the teacher, want, a comprehensive catalog of available resources, and more communication with anyone serving the cause of improving mathematics education in Cleveland. We have enjoyed having the pleasure of the company of one-half of all Cleveland math teachers at the Resource Center, but to the other half, in the words of Mae West, "Come on up and see us sometime!" Thanks again to all who have made this a good start for the Resource Center.

Ken Fiore, Les Moes, and Dick Mueller

JOHN CARROLL

As part of its commitment to C²ME the Mathematics Department of John Carroll University is offering a limited number of tuition scholarships to mathematics teachers in the Cleveland Public School System. These scholarships will cover tuition for mathematics courses in the 1986 Summer and Fall offerings of the department. Summer offerings include courses in Projective Geometry, Linear Algebra, Number Theory, and the History of Mathematics, as well as introductory courses in Calculus, Statistics, and Discrete Mathematics. The scholarships will be awarded on a competitive basis by a committee of the department. A letter describing the applicant's academic and teaching backgrounds and stating the applicant's reasons for applying is required. A letter of recommendation from the applicant's department chair or principal is also required. Further information, as well as a detailed schedule of approved courses, may be obtained by calling 397-4351 or writing Dr. R. J. Kolesar, Chair, Department of Mathematics and Computer Science, John Carroll University, Cleveland, Ohio 44118.

NAMES

WORKSHOP

Again this year the Martha Holden Jennings Foundation will be sponsoring a summer mathematics workshop. Susan Bobka, mathematics teacher at Whitney Young, will be attending this one-week workshop. We know that she will enjoy the workshop leader, Dr. Johnny F. Hill from Miami University.

OBERLIN ACADEMY

Three teachers, Robert Seitz (John Adams), Margaret Reed (Cleveland School of Science) and Sara Vigil (Margaret Spellacy) have been selected to receive scholarships from Oberlin College to participate in the Mathematical Problem Solving workshop which will be conducted this summer.

The course will be taught by Oberlin High School Mathematics teacher, Rudd Crawford. Dr. Crawford is director of the Stella Project in Mathematical Problem Solving at Oberlin High School for which he has received national recognition. Problem Solving strategies and activities will be shared with teachers during fall inservice.

COMPUTER CONFERENCE

Wallace Havenhill and William Stiggers were recently selected to participate in a week long conference this summer at Phillips Exeter Academy in Exeter, New Hampshire. The cost of the workshop is being underwritten by the Education Development Center Incorporated located in Newton, Massachusetts.

Bill and Wally will be sharing information obtained from the conference with members of the collaborative and will assist as we implement computer applications into the mathematics curriculum.

SCHOOL NEWS

William Stiggers, mathematics teacher at Whitney Young Junior High School, recently participated in a round table discussion in New York City sponsored by the Macmillan Publishing Company. The topic of discussion was the content of seventh and eighth grade mathematics textbooks. Also attending the discussion were teacher representatives and supervisors from major districts across the country. The Macmillan Publishing Company was very impressed with our representative.

SPOT NEWS

SUMMER INSERVICE

Plans are underway for inservice training to take place during the latter part of August. Inservice will be provided for all intermediate mathematics teachers as well as all senior high mathematics teachers. Inservice will focus upon competency testing, SAT preparation, problem solving and the use of calculators and computers. Further information will be sent to all secondary mathematics teachers.

POSTER AVAILABLE

There is a useful poster for the classroom available which charts over 100 occupations according to the mathematics applications they utilize. The poster is entitled "When Are We Ever Going To Have To Use This?" It can be ordered from Dale Seymour Publications; P.O. Box 10888, Palo Alto, CA 94303 for $4.95. The ordering number is 01344. There is also an accompanying book (same title) by Hal Saunders which has many good problems. The price of the book is $7.95 and the ordering number is 01343.

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